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Article

Quinoa pasta influences some biochemical markers in consumers

Amanda. C. Mora [1], Mary Lares [2], Rafael H. Gutiérrez [2,*], Raquel O. Diaz [1], María S. Hernández [1], J. Pablo Fernández-Trujillo [3]

[1] Instituto de Ciencia y Tecnología de Alimentos ICTA Universidad Nacional de Colombia,

[2] Universidad Central de Venezuela, Escuela de Nutrición y Dietética, 3er floor Residencias Femeninas, entrada plaza Venezuela, frente a las canchas de tenis, Ciudad Universitaria, Caracas, Venezuela; E-Mails: rafgutii@hotmail.com,

[3] Universidad Politécnica de Cartagena (UPCT). Department of Agricultural and Food Engineering. Paseo Alfonso XIII, 48. ETSIA. E-30203 Cartagena (Murcia), Spain; E-Mails: juanp.fdez@upct.es

***** Author to whom correspondence should be addressed; E-Mail: rafgutii@hotmail.com; Tel.+58 212-6050604 Venezuela.

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Abstract: Quinoa is a pseudo-cereal that is considered part of the pre-Columbian indigenous food habits given its good nutritional quality and potential due to its easy development under different environmental conditions with simple technologies. Pasta with partial substitution with quinoa can represent benefits for consumer health and nutrition, as it has better nutritional quality compared to market pasta with 100% wheat semolina. The effect of pasta consumption with a higher degree of substitution (30%) with quinoa flour (Blanca Jerico and Aurora cultivars) was explored to determine the potential benefits on cardiovascular risk markers in a healthy population. Anthropometric measurements, dietary assessment, lipid markers of oxidative stress, inflammation and thrombosis were evaluated in a selected healthy population of 10 individuals aged between 25 and 60 years. The effect of consumption of the pasta on the biochemical markers: total cholesterol, HDL and LDL cholesterol, triglycerides, glucose, uric acid, creatinine and insulin in the metabolically healthy population was not statistically different for any of these markers before and after intake of the quinoa substituted pasta. According to these results, the ingestion of the pasta does not influence the evaluated parameters and can be utilized in special diet regimes.

Keywords: Biomarkers; flour substitution; food effect; health

1. Introduction

Quinoa is a pseudo-cereal that is considered part of the pre-Columbian indigenous food habits, with high nutritional quality due to the valuable content of essential amino acids, a fatty acid profile rich in essential fatty acids such as linoleic and linolenic, a good content of fiber [1] and minerals such as calcium, iron, zinc, copper and manganese. Quinoa has a high capacity to adapt to adverse climatic and agricultural conditions with a high yield [2].

Quinoa grains are directly used in various culinary dishes. Sprouts are mainly used in vegetarian food. Quinoa is also an ingredient in tortillas, pancakes, and in muesli or granola type products for breakfast, (replacing wheat flakes), being equal in expansion and extrusion. For industrial products, quinoa is used to produce beer, industrial alcohol, saponine, quinoline, quinoic acid, cardboard from cellulose, good quality starch, flour, oil, etc. [2,3]

The highly nutritive quinoa flour is used as a protein supplement in wheat flour and in the preparation of cakes, pastries, pasta and baked goods [4]. Currently, there have been advances in research on the use of quinoa flour in composite flour for making bread products, biscuits and pastries [5].

The average recommended serving of plain cooked pasta, or with egg, is 240 g, which is equivalent to 80g of raw pasta without filling. The caloric intake is between 240 and 369 kcal, depending on whether the pasta is simple or stuffed, which represents 14.5-18% of the energy for a 2000 kcal diet; the carbohydrate intake is 30-55 g per serving, with 20% of recommended proteins [6].

The pastas are highly energetic foods and are recommended in the habitual diet of the population and, in particular, for those that require more energy input - children, teenagers, people with highly active or physical professions - and in certain diseases and convalescence periods in which the input is required to increase caloric intake [6]. Pastas have been associated with hyperglycemic food, even more than bread, rice and potatoes. However, pastas are manufactured based on hard wheat flour and other cereals, called semolina, unlike bread made with fine flour, so it is assumed that the glycemic response should be less than that of bread.

The glycemic index (GI) is a ranking of foods based on the response of postprandial blood glucose as compared with a reference food (white bread or glucose solution). A low GI (≤ 70%) diet is considered healthy, particularly in the prevention of obesity, type 2 diabetes and cardiovascular diseases [7,8]. The GI is positively associated with metabolic syndrome and insulin resistance. In the Framingham study, it was shown that individuals who consumed high GI products had a 41% higher risk of having metabolic syndrome, and consequently a higher cardiovascular risk than those who consumed low GI diets [9].

Based on the above considerations, the production of pasta made with semolina flour and quinoa has been proposed to improve consumption of macronutrients and micronutrients when it was sensory acceptable by consumers. These modified pasta might be included in diet programs for children and vulnerable populations and the general public, both domestic and internationally; with a previous assessment on health effects. Therefore the objective of this work is the evaluation of the effect of consumption of pasta with 30 % quinoa substitution on cardiovascular risk markers in a healthy population in order to make a preliminary recommendation about his consumption.

2. Experimental Section

A healthy population was selected consisting of 10 metabolically healthy adults, aged 25 to 60 years, of which only 7 completed the study, recruited from the endocrinology department of the Hospital Militar "Dr. Carlos Arvelo" Caracas, Venezuela and the school of Nutrición y Dietética of the Universidad Central de Venezuela. We excluded subjects with chronic diseases, diabetes, infections, autoimmune diseases, surgery-treated obesity and subjects with a regular consumption of alcohol or drugs, pregnant women and those with antiplatelet or antioxidant therapy. The assay was initiated following approval of the ethics committee of our institution and the signed informed consent, according to the Helsinki protocol, of patients who met the inclusion and exclusion criteria.

Participants were asked if they would like to participate and whether they would comply with a studied consumption of 70g/day of pasta, three times a week, the only pasta intake during this time. All participants underwent assessment of systolic and diastolic blood pressure, anthropometric measurements, dietary assessment and biochemical markers such as total cholesterol, HDL and LDL cholesterol, triglycerides, glucose, uric acid, creatinine, insulin, inflammation and prothrombosis before and weeks after the consumption of the pasta.

The pasta supplied was made from mixtures of wheat semolina and quinoa flour (Blanca Jerico and Aurora cultivars), which had a composition of 23.81 of quinoa flour and 55.56 of wheat semolina for 100g of dough mix, and was processed in the pilot plant of Instituto de Ciencia y Tecnología de Alimentos (Universidad Nacional de Colombia, Bogotá), every individual was given three 70g pre-weighed portions, providing a total of 210 grams of pasta per week. The indicated cooking time for the pasta was 8 minutes.

Each subject fasted 14 hours and 30 mL of peripheral blood were extracted into 6 Vacutainer tubes with and without EDTA, which were centrifuged at 1000g for 20 minutes, separating the serum and plasma for the determination of total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, glucose, creatinine, uric acid, using kits for the enzymatic colorimetric method from Roche Diagnostics CA; insulin, with a Roche Diagnostics kit with electrochemiluminescence; Prothrombotic: Fibrinogen with a commercial kit and inflammation: tumor necrosis factor determined by the ELISA method using commercial kits from Endogen Human.

For anthropometric evaluation, measurements of body weight, maximum height and waist circumference was conducted following the methodology of the "Programa Internacional de Biología" [10]. A TANITA UM-080 ® digital scale was used, fiberglass tape affixed to the wall and bracket, and anthropometric fiberglass tape, strong, flexible and inelastic. The body mass index (BMI) was determined from the previous results using the OMS classification.

For dietary assessment, the application of two techniques for measuring food consumption was followed: a journal of the food intake of a usual or typical day and a questionnaire for the qualitative frequency of food consumption. In order to estimate the quantities of food consumed to apply the journal, support units were used, such as cups, tablespoons and cups [11]. For unique dishes or mixed preparations, standardized recipes were used [12]. The calculation of calories and nutrients provided by the diet was carried out based on the information provided by the table of food composition from INN of Venezuela 2000 [13] or nutritional labeling.

For the statistical management of the dietary assessment, a database was built with Office Excel 2007® and with its tools. A statistical treatment was carried out that included measurements of central tendency and dispersion for the quantitative variables and frequency distributions for the qualitative variables. The statistical analysis of the biochemical and anthropometric measurements of the results is expressed as the mean ± standard deviation. An analysis of variance was performed with a SPSS 2004 using time of quinoa pasta consumption (before or after consumption). If significant differences were found, a Student´s test was conducted at $p \leq 0.05$.

3. Results and Discussion

No significant differences due to the consumption of the pasta were found for the anthropometric measures (Table 1), neither in the dietary evaluation on the indicators of energy intake (kcal/day), nor in the contribution of total protein, animal protein and plant protein and total fat, animal fat and plant fat, carbohydrates, fiber (g/day) or cholesterol intake (mg/day). These results indicate that the diet remained constant during this week without variations in the contribution of these macronutrients.

As regards biochemical markers (Table 2), any of the parameters evaluated showed significant differences with the use of 210g of pasta per week (70 g/day with a contribution of 50 g carbohydrate), indicating no apparent effects on lipids, nor on the blood glucose levels or insulin baseline. It is interesting to remark that quinoa pasta intake did not produce lipidic profile, glycemic and insulin increases, by consumption frecuency of three times a week, therefore it is recommend to consume quinoa pasta frecuently.

Quinoa could be considered as a nutraceutical food due to favourable efects on hiperglycemia and free fatty acids diminishing [14]. Berti *et al*. [15] found that celiac patients that consume quinua shows a lower glycemic index, lower levels of free fatty acids and lower triglycerides content than those who consume free gluten bread and/or paste. Additionally, quinoa leads to in patients which consume quinoa compare to those who did not.

When evaluating the effect of the paste consumption from the inflammatory viewpoint, there were no significant differences for the tumor necrosis factor α values. The TNF α is a cytokine produced mainly by monocytes / macrophages that has many biological activities that can cause physiological changes common in diseased states. It is a member of a group of other cytokines which stimulate an acute phase of inflammatory reaction [16]. Inflammation is a key mechanism of atherogenesis and the rapid progression of coronary artery disease [17].

The recognition of atherosclerosis as an inflammatory disease is well established and a variety of systemic inflammatory markers are also related to cardiovascular events [18]. Fibrinogen is an independent cardiovascular risk factor, and is considered a prothrombotic marker of cardiovascular risk in Type 2 Diabetes and dyslipidemia [19]. Fibrinogen level was unaffected by pasta consumption (Table 2). Blood viscosity has in fibrinogen its main determinant, and when elevated can lead to decreased blood flow in the microcirculation, to endothelial injury due to increased wall stress and potentially to predisposition to thrombotic events [20]. Like an acute phase protein, elevated levels of fibrinogen serum can indicate degrees of subliminal inflammation that are characteristic of atherosclerosis; the reasons are not completely clear, but this may occur due to various stimuli such as oxidized LDL, cytokines, oxygen free radicals and other factors that are not common in chronic infectious processes [21].

Macdonald *et al.* [22] in a study of type 1 diabetics under an insulin therapy regimen, observed that the pasta caused a lower glycemic response than rice noodles, Thai hamburger and sandwiches. Therefore, pasta with quinoa could be a possible alternative as it has fatty acids such as linoleic and linolenic, fiber, calcium, iron, zinc, copper and manganese that could support balanced diets for diabetic patients, in addition, the complex carbohydrates elicit a lower glucose and insulin response than refined ones because their absorption is slower. This effect would be beneficial for individuals with insulin resistance or diabetes.

On the other hand, foods with a low glycemic index (GI) are associated with a greater feeling of satiety, because they delay gastric emptying. Generally, foods that induce a low glycemic response are rich in fiber, prolonging gastric distension, probably causing an increase in peptides associated with satiety. In a recent study comparing the effect of whole grain bread with refined grain and pasta, the pasta was observed to have a lower glycemic response than the breads and a greater satiety effect that the refined flour bread [23].

4. Conclusions

The consumption of pasta including 30% quinoa flour showed no difference in the anthropometric evaluation, dietary assessment or biochemical markers. The incorporation of this product into diets and special regimes is recommended.

In future research is advice to evaluate the effect on these markers due to the consumption of pasta including 30% quinoa flour during a prolonged time in an older population. Also is needed to measure the glycemic index of this kind of pasta.

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Conflict of Interest

The authors declare no conflict of interest.

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TABLES AND FIGURES

Table 1. Effect of pasta consumption at the level of the anthropometric measurements and blood pressure. Averages followed by different letters in the same row are significantly different at p≤0.05) according to the Student test.

Variables and Indicators	Before consumption	After consumption
Age	38.8 ± 14.2	
Weight (Kg)	60.75 ± 14.8 a	60.95 ± 14.5 a
Height (m)	1.61 ± 0.1 a	1.61 ± 0.1 a
BMI	23.25 ± 4.1 a	23.33± 4.0 a
Waist circumference (cm)	83.67 ± 11.1 a	84.00 ± 11.1 a
Systolic blood pressure (mm Hg)	118.00 ± 1.4 a	115.00 ± 7.1 a
Diastolic blood pressure (mm Hg)	78.00 ± 1.4 a	78.00 ± 2.8 a

Table2. Evaluation of the effect of pasta consumption on the quantification of the biochemical markers (mean ± SD). Averages followed by different letters in the same row are significantly different at p≤0.05) according to the Student test.

Clinical laboratory parameter	Before consumption	After consumption
Total cholesterol (mg/dL)	167.60 ± 28.8 a	159.80 ± 31.3 a
Triglycerides (mg/dL)	92.00 ± 32.7 a	108.75 ± 65.9 a
HDL-cholesterol (mg/dL)	41.60 ± 5.9 a	42.20 ± 7.6 a
LDL-cholesterol (mg/dL)	96.8 ± 16.1 a	85.80 ± 20.9 a
Glucose (mg/dL)	88.80 ± 8.8 a	89.40 ± 4.7 a
Uric acid (mg/dL)	5.38 ± 1.6 a	4.82 ± 1.1 a
Creatinine (mg/dL)	0.84 ± 0.1 a	0.80 ± 0.2 a
Insulin (µIU/mL)	8.20 ± 2.1 a	8.40 ± 2.5 a
Tumor necrosis factor α (pg/mL)	8.9± 1.2 a	8.5 ± 1.3 a
Fibrinogen (mg/dL)	328 ± 29 a	302 ± 32 a